#2
4/25/02
M. Rudgis

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	:	
Jonathan Samuel Dring et al.	:	
Serial No.: To be assigned	:	Art Unit: To be assigned
Filed: Herewith	:	Examiner: To be assigned
For: Arc Detection	:	Atty Docket: 20272/0701

SUBMISSION OF CERTIFIED PRIORITY DOCUMENT(S) and CLAIM TO PRIORITY UNDER 35 U.S.C. § 119

Commissioner for Patents
Washington, D.C. 20231

Sir:

Priority under 35 U.S.C. § 119 is hereby claimed to the following priority document(s), certified copies of which are enclosed. The documents were filed in a foreign country within the proper statutory period prior to the filing of the above-referenced United States patent application.

Priority Document Serial No.	Country	Filing Date
0104763.8	Great Britain	February 27, 2001

Acknowledgement of this claim and submission in the next official communication is respectfully requested.

Respectfully submitted,

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Date: 2-28-02

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

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Signed: M Parker

Dated: 11 December 2001

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27FEB01 E609251-1 C26047
P01/7700 0.00-0104763.8

Request for grant of a patent

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The Patent Office

Cardiff Road
Newport
South Wales
NP10 8QQ

1. Your reference

0100210

2. Patent application number
(The Patent Office will fill in this part)

0104763.8

27 FEB 2001

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

SMITHS GROUP PLC
765 FINCHLEY ROAD
LONDON
NW11 8DS

Patents ADP number *(if you know it)*

728708002

If the applicant is a corporate body, give the country/state of its incorporation

80 32 31 0001
GB

4. Title of the invention

ARC DETECTION

5. Name of your agent *(if you have one)*

J. M. FLINT

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

765 FINCHLEY ROAD
LONDON
NW11 8DS

Patents ADP number *(if you know it)*

1063288002

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

YES

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	5
Claim(s)	
Abstract	
Drawing(s)	1+1

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature J. Flint Date 23/02/01

12. Name and daytime telephone number of person to contact in the United Kingdom J.M. FLINT 020 8457 8220

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ARC DETECTION

This invention relates to methods and apparatus for detecting arc faults in electrical systems.

Electrical systems may suffer from arcing between parts of the system at different voltages or between a part of the system and earth. The presence of an arc may be indicative of a breakdown in insulation or some other fault. Because arcing prevents proper operation of the system and may cause damage or fire risk, it is important that the arcing be detected rapidly and accurately. It can, however, be difficult to distinguish between arcs caused by faults, such as insulation damage, and arcs produced in normal operation, such as in ac motor commutators, thyristor-controlled loads, switchgear and the like. It is important to minimize the number of false arc alarms produced since these may result in a circuit breaker being tripped and an interruption of power supply to equipment.

In US4316139 there is described an arc detection system including detectors responsive to vibration and electromagnetic disturbances produced by an arc. EP 639879A, EP 813281A, GB 2177561 and WO 97/30501 also describe arc detection systems.

It is an object of the present invention to provide an alternative method and system for detecting arcing.

According to one aspect of the present invention there is provided a system for detecting arc faults in an electrical circuit including a store of a plurality of temporal models

of electrical events associated with arc faults and of events not associated with arc faults, means for extracting from the circuit electrical signals associated with electrical events in said circuit, means for processing the signals into a form suitable for comparison with the models, and means for comparing said processed signals with the models to determine whether the event giving rise to said signals is an arc fault or not.

According to another aspect of the present invention there is provided a system for detecting arc faults in an electrical circuit including an artificial neural net programmed to recognise features of different arcs so as to enable arcs caused by faults in the circuit to be distinguished from other arcs.

According to a further aspect of the present invention there is provided a method of detecting an arc fault in a circuit including the steps of extracting signals from the circuit, processing the signals into a form suitable for comparison, comparing the processed signals with a plurality of stored temporal models representative of both arc faults and events not associated with arc faults, and providing an output in accordance therewith.

According to a fourth aspect of the present invention there is provided a method of detecting an arc fault in a circuit including the steps of extracting signals from the circuit, processing the signals into a form suitable for comparison, supplying the processed signals to an artificial neural net programmed to recognise features of different arcs so as to enable arcs caused by faults in the circuit to be distinguished from other arcs and providing an output in accordance therewith.

A system and method according to the present invention, will now be described, by way of example, with reference to the accompanying drawing which is a schematic diagram of the system.

The system includes a power generator 1 connected to a load 2 via a transmission line 3 including a circuit breaker 4 and a current transducer 5. The system also includes arc detection apparatus indicated generally by the numeral 10 connected to receive an output from the current transducer 5 and a voltage output from the generator 1 via line 11. The arc detection apparatus provides an output on line 12 to control operation of the circuit breaker 4, that is, to open the breaker when it detects an arc fault.

The arc detection apparatus 10 includes a voltage conditioning unit 13, which receives the voltage output on line 11, and a current conditioning unit 14, which receives the output from the current transducer 5. The voltage and current conditioning units 13 and 14 each provide output signals to a digital signal processing unit 15. The digital processing unit 15 also receives input signals from a memory 16.

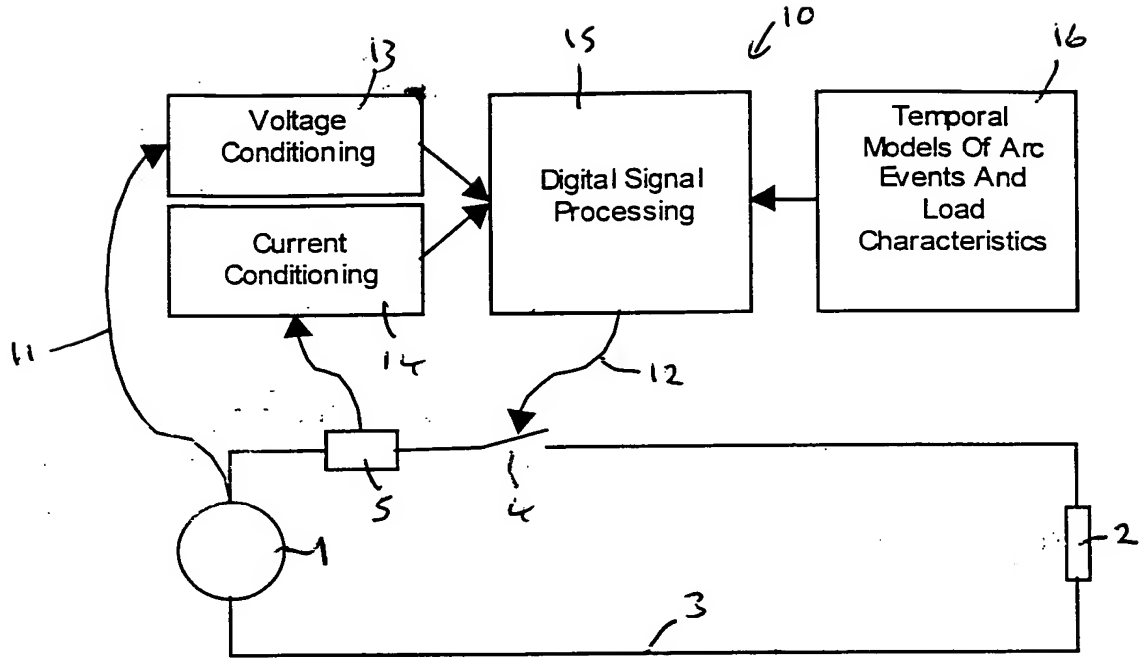
The memory 16 contains temporal models of arc events and load characteristics, these may be in the form of templates or stochastic models and contain information about various arc features characteristic of arc faults and of false trip events. These templates can contain any number of electrical, mathematical or spectral features, such as accumulated differential of voltage and/or current and a high frequency spectrum, to form an arc feature set. The templates or models can be calculated over various time periods, such as a single half cycle or over a group of whole cycles of the voltage or current waveform. Standard training

algorithms exist for calculating a Markov model (such as, Baum re-estimation). The Markov model can encapsulate temporal information to improve discrimination, such as to enable discrimination between repetitive commutator motor signatures and true arc fault events.

In operation, the voltage and current conditioning units 13 and 14 extract the discriminative arc features from their inputs and supply these to the processing unit 15. In the processing unit 15 these features are matched against the stored models in the memory 16 using a classification algorithm. The algorithm determines whether the detected arc features are characteristic of a true arc fault, such as caused by insulation breakdown, or are characteristic of non-fault arcs, such as motor commutator arcs. The processing unit 15 may calculate probabilities of occurrence of each arc model over time. These may be linked to an arc probability threshold so that the more commonly occurring events can be recognised rapidly. Where non-fault arc events have similar characteristics to fault signals, more detailed models can be created to ensure accurate discrimination between the two.

In normal operation, the power generator 1 supplies power to the load 2 via the transmission line 3. When the processing unit 15 detects a true fault arc it supplies a signal on line 12 to open the circuit breaker 4 and, hence, disconnect supply of power to the load and the associated transmission line 3. Alternatively, the processing unit 15 could be arranged to supply an output to an alarm, a maintenance recorder or to some external circuit to indicate that a fault has occurred.

Instead of storing stochastic models in the memory 16, an artificial neural net can be used. This would be taught to recognise arc signatures of different origins as represented by groups of features of the signatures.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Voltage Conditioning
Current Conditioning
Digital Signal Processing
Temporal Models Of Arc Events And Load Characteristics
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